High Quality Search Results for HEC

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Exascale indexing

- Exascale means billions to trillions of files, within an order of magnitude of the current web
- Much like the web in 1999 did, current efforts in indexing focus on a SQL-like query language (SPARQL, QUASAR...)
- Query capabilities are lagging behind scale

But I like SQL!

- Great for power users!
- Not so great for scientists
- Formal query languages are hard for novice users
- Queries are either under or over-specific
- Exploratory queries versus seeking queries
- Too much of a billion files is WAY too much

Empower Users

- Allow users to be only as specific as they need to be
- Degrade gracefully from formal queries to keyword search
- Give users the ability to explore as well as find
- Give users ranked search

Why can't we just use Google?

- Google relies on the innate structure of the web
- Links between pages are implicit endorsements
- Current file system structures:
  - Directories?
  - Hard/soft links?
  - File names?
  - Access times?
- None of these are actually endorsements
- Without this, Google (and other modern search engines) are <u>just another similarity search</u>

Better endorsements

- Really want a measure of how popular a file is
  - How often is it accessed?
  - How recently?
  - By how many users?
- Usage patterns are a clear endorsement
- We need new metadata to measure this

One simple implementation

- Probabilistic access counters
- Decayed over time to favor recently popular files
- Require only one new int as a metadata field
- Can be implemented very efficiently
- Simple, not very powerful
- Is different from most existing ranking algorithms
- Not very customizable
- Better than nothing

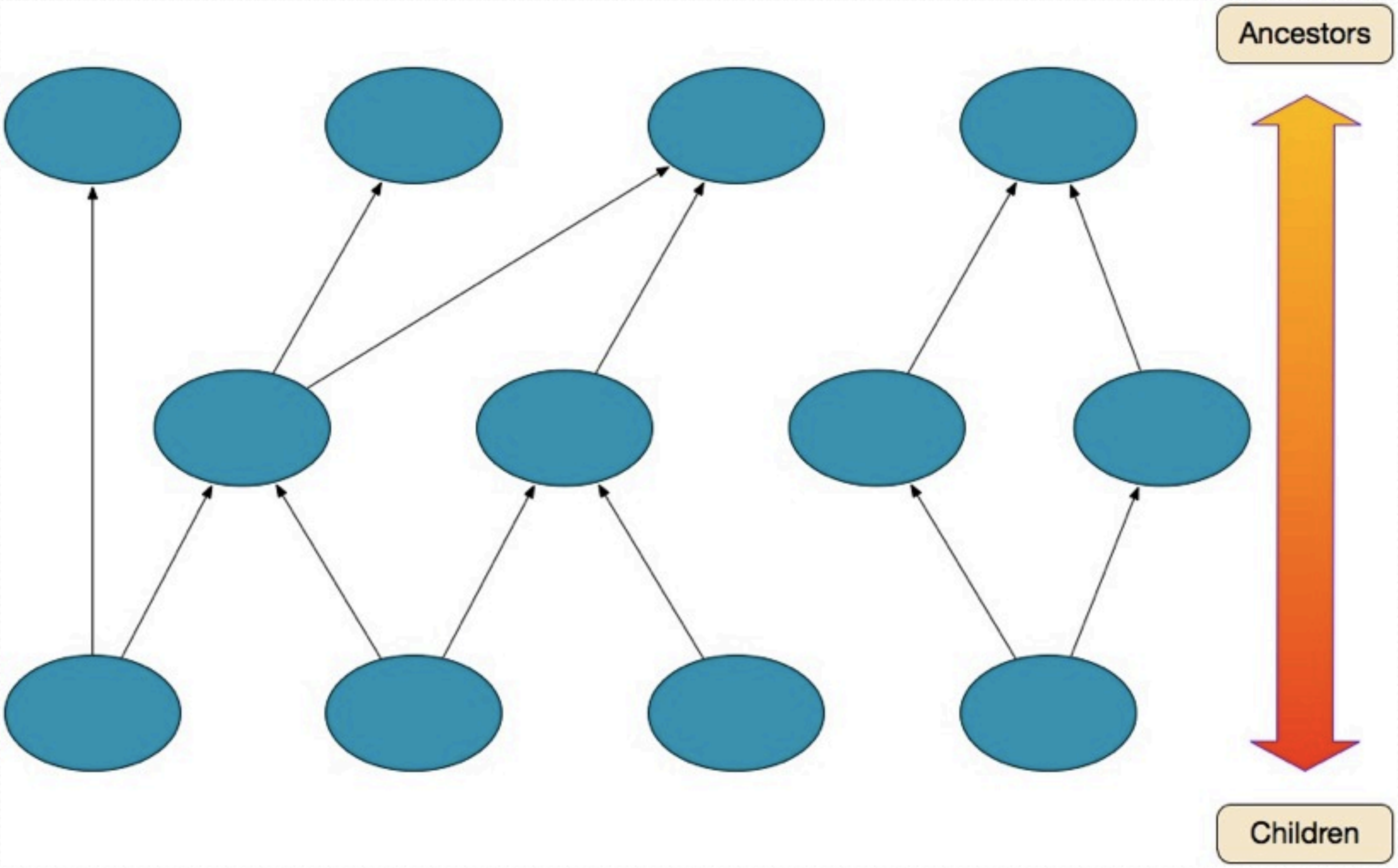
File system level provenance

- Not a new idea (Seltzer 2006, Cao 2005)
- Track data flow, file opens, files closes
- In combination with other metadata, can tell us:
  - How many people used a file
  - How recently
  - How often
- By interpreting provenance as endorsement, we can **leverage** existing ranking algorithms, and **create** new ones

P-rank

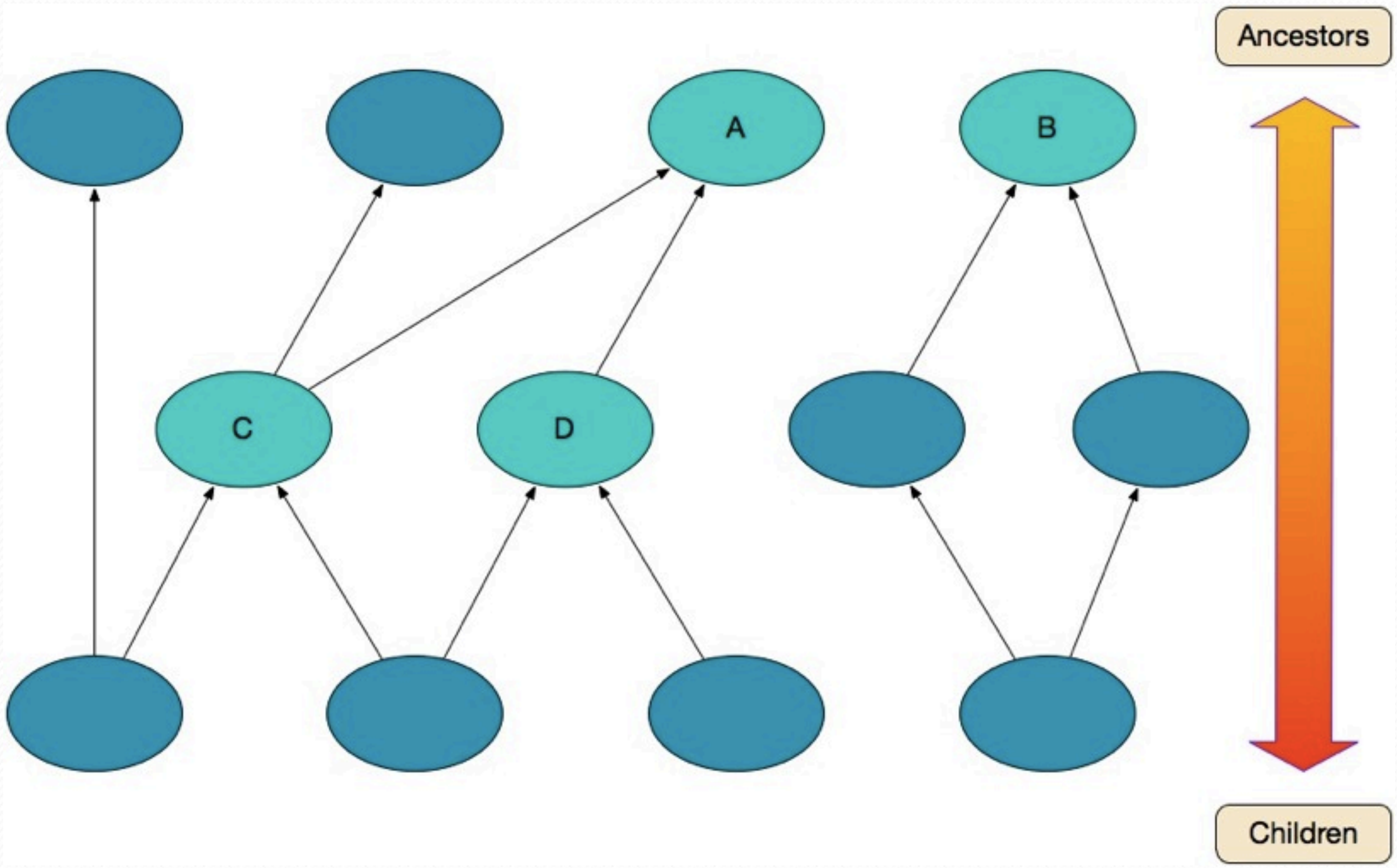
- Like Google’s PageRank, relies on matrix manipulation
- Modern HPC is very good at parallel matrix math
- Provenance is static once recorded
- Large parts of the matrix don't need recalculation

P-Rank



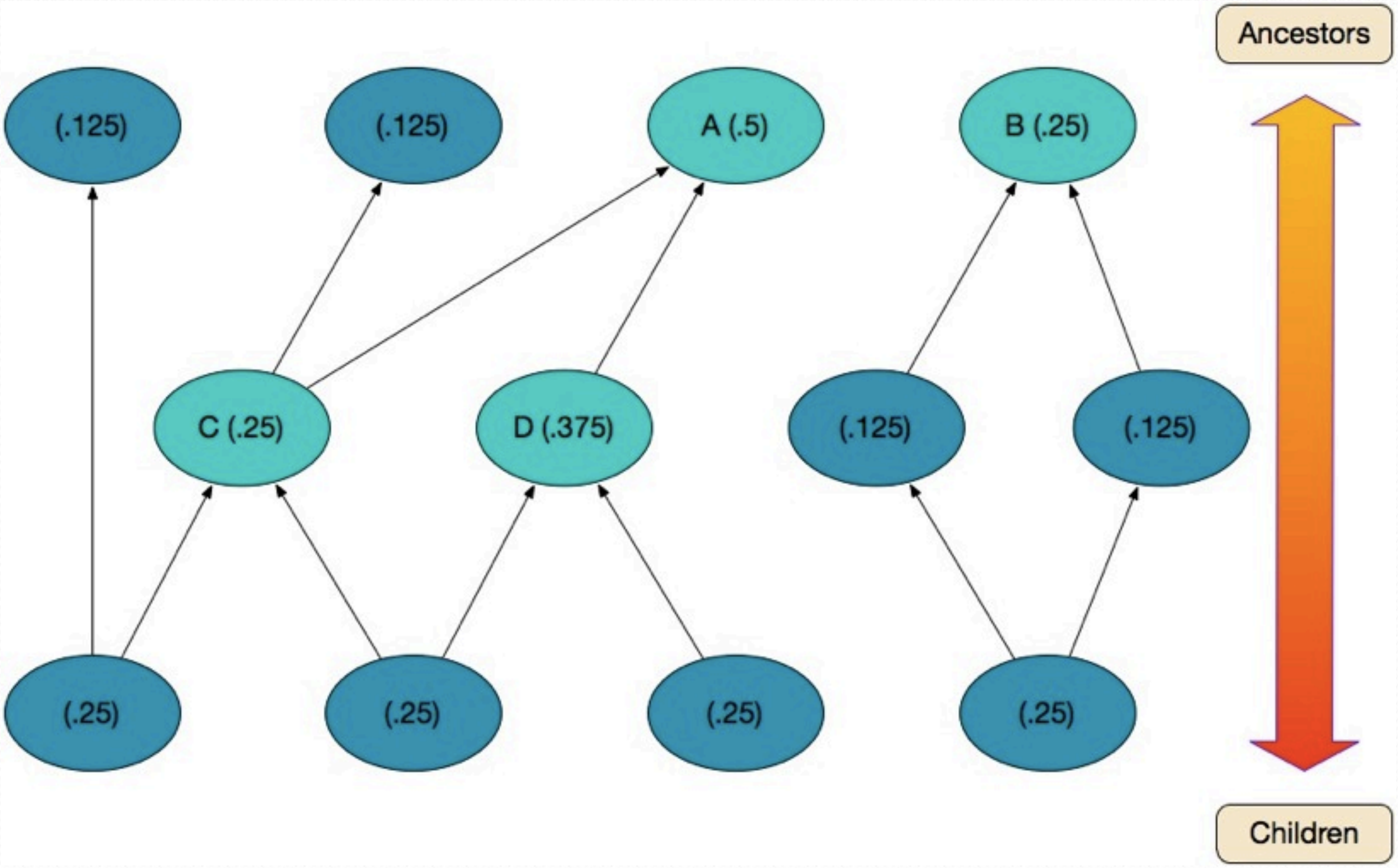
Example prov graph

P-Rank



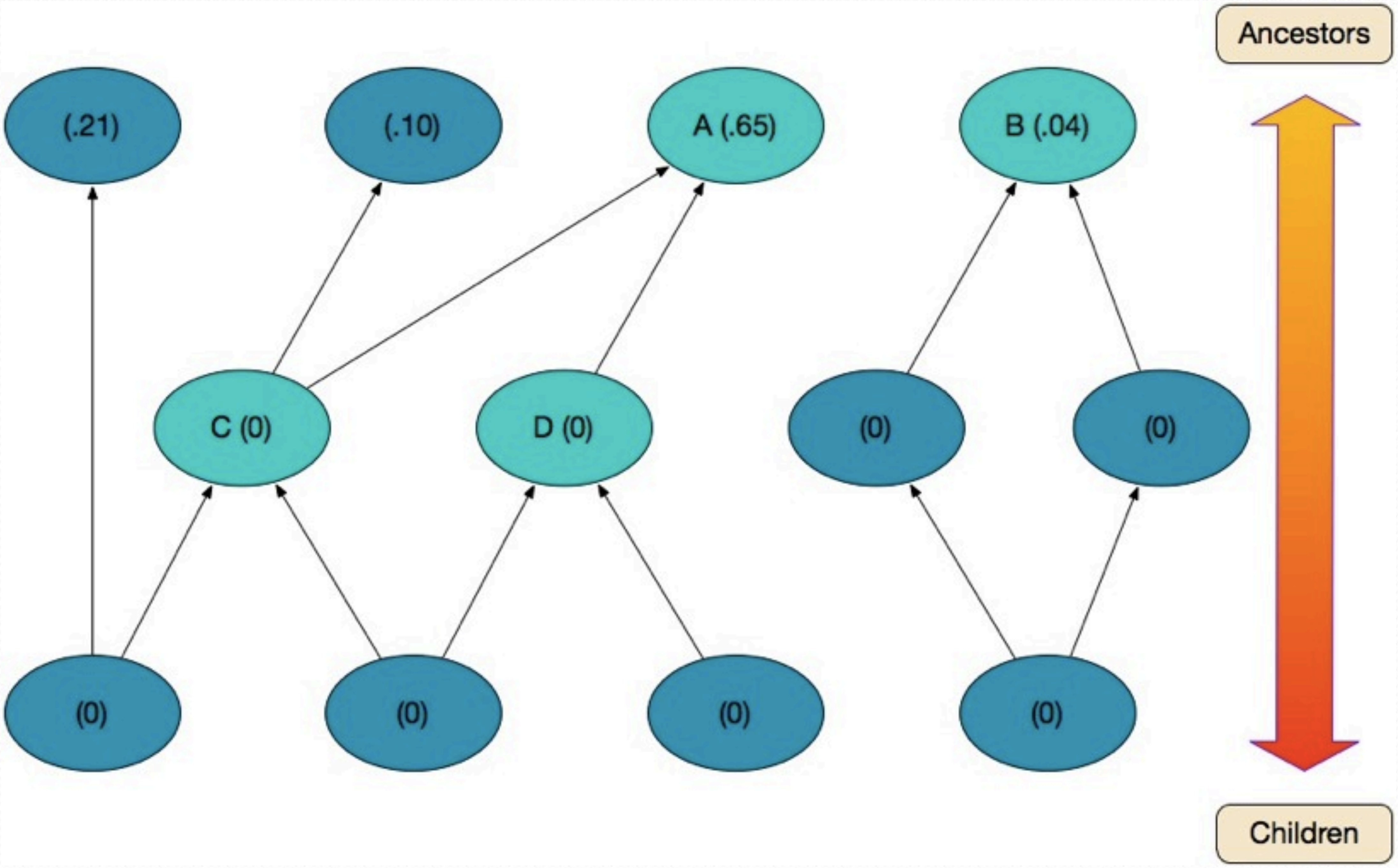
Call out popular nodes (high in-degree)

P-Rank



Add some probabilities (start at leaves, uniform transition along each link)

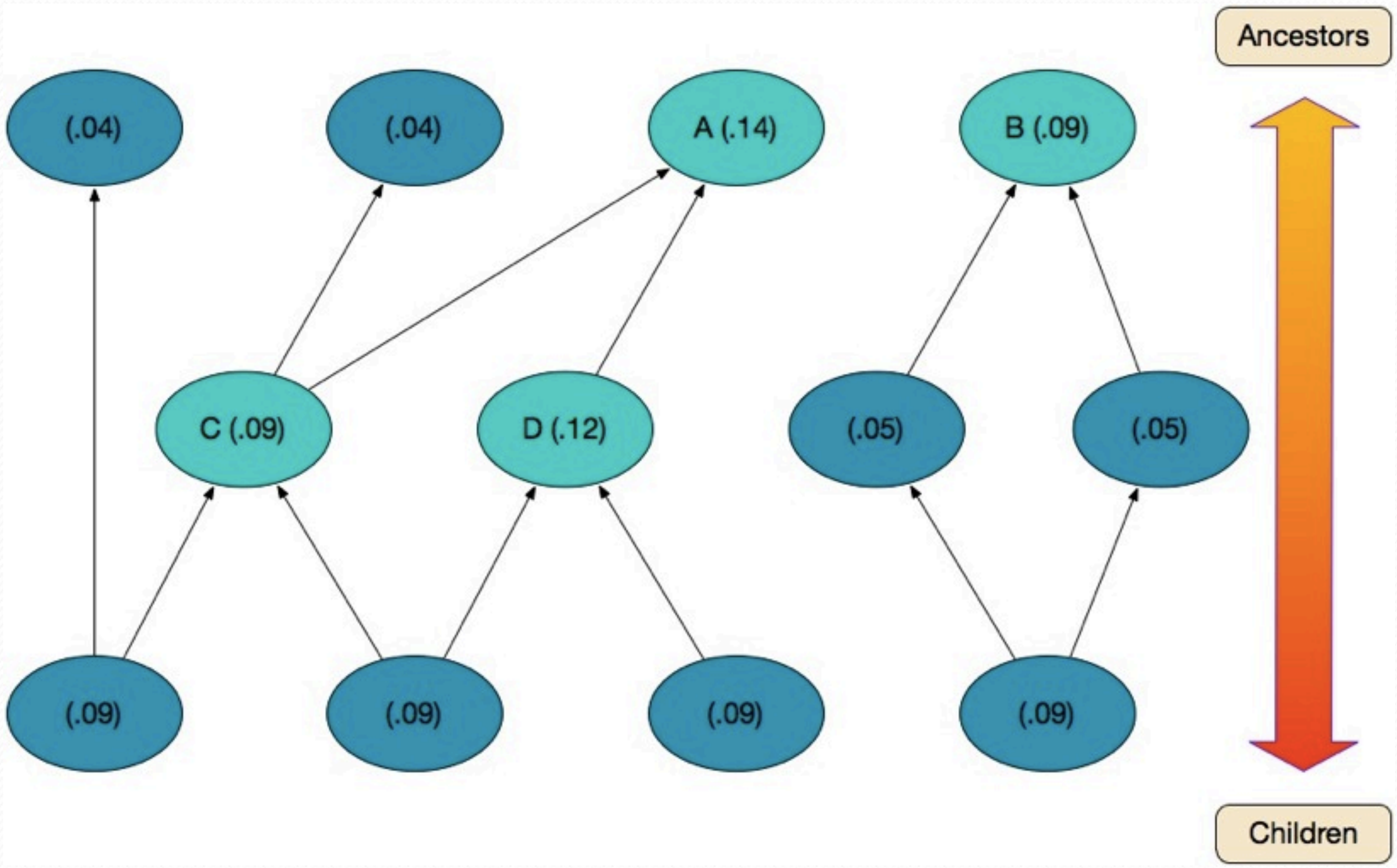
P-Rank



Monday, August 8, 2011

Pure page rank with a 25% teleport probability

P-Rank



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Weighted page rank with leaf teleportation only

Personalization opportunities

- We have more information than Google does
- We can associate the *querier* with the *content creator*
- Having a rich graph allows us to do smarter queries

New types of queries

- Social network analysis
  - "Show me only my files"
  - “Find my working groups and boost files by them”
  - “Show me publicly visible files for my new team”
- "Show me codes compiled with this buggy library"
- Emigrant data forensics (Strong 2011)

Conclusion

- Ranked search has proven to be a powerful enabler on the web
- Has non-obvious performance benefits
- File systems lack structure for effective ranking
- With a modicum of metadata, we can do more
  - Ranked search
  - Personalized search
  - Powerful new queries